REMARKS

Applicants thank Examiner Bryan S. Tung for the courtesy of telephone interviews in late July and early August, to discuss some of the cited art and to discuss a preliminary draft of one of the main new claims (which is now claim 36) in this amendment.

It is understood that the Examiner, in view of the already-protracted prior prosecution of this case, has graciously agreed to contact the undersigned by phone to attempt to resolve problems in the present claims, before proceeding with a further Official Action. Applicants are particularly grateful to the Examiner for his willingness to expedite the prosecution in this way.

Applicants also wish to thank Examiner Tung for having indicated that claims 9, 18, 23 and 28 would be allowable if rewritten to overcome rejections under § 112.

The Applicants have amended originally independent claims 1, 10 and 19 to incorporate the subject matter of claims 9, 18 and 23 respectively -- and also to overcome the § 112 rejections of all those six claims. Applicants have also amended claim 28 to incorporate the subject matter of original independent claim 23 -- and also to overcome the § 112 rejections of both claims.

Accordingly amended claims 1, 10, 19 and 28 are believed to be in condition for allowance.

REJECTIONS UNDER § 103

All the other claims originally filed in this application have been rejected as obvious over Alfano '372 in view of Knight -- or over those references further in view of Takaoka.

Applicants respectfully submit that the present invention is distinguished from the Knight/Alfano combination in several crucial ways:

- Illumination-propagation and -collection paths

  Applicants' invention projects light along a path to and through the ocean or other turbid medium -- and then collects light reflected along very nearly the same path as the incident light. This geometry (1) is important to enable use of vehicle-carrying systems, also (2) provides valuable signal-to-noise benefits through use of direct backscatter, and furthermore (3) enormously simplifies mapping and data interpretation as will be seen shortly.

  Alfano's invention collects reflected light at right angles to the incident light.

• Probe-beam shapes

Applicants' invention projects a very thin (fore-to-aft) beam toward the turbid medium -- essentially a needle-shaped, line-shaped or unidimensional probe of laser light that propagates through the medium (sideways of the needle or line shape). The illumination is thus extremely selective.

Alfano's invention evidently projects a generally round or square beam, creating a two-dimensional light probe in the shape of a flat plane -- which is thus directed in a very nonselective way toward an object of interest -- and he correspondingly develops a two-dimensional reflected image which must somehow be adapted for input to his streak tube.

• Streak-tube inputs

The reflections received at Applicants' streak-tube cathode are unidimensional or needle-shaped, corresponding to the unidimensional probe-beam shape. Applicants' system thus generates a streak-tube input that is inherently one-dimensional.

Alfano, as will be seen shortly, instead must go to extra lengths to provide an ARTIFICIAL one-dimensional input for his streak tube -- and then later undo the effects of this synthetic process.

- Nature of the mapping

Applicants' invention carries out a very natural, instinctively straightforward mapping of (1) light-propagation depth in the ocean or other medium to (2) vertical position on the streak-tube display screen.

Alfano's invention instead performs a 3D-to-2D mapping of (1) the entire turbid-medium VOLUME onto (2) his display-screen AREA.

The Applicants' apparatus invention -- to map ocean depth into vertical display-screen position -- simply feeds the inherently unidimensional collected reflections into the inherently unidimensional streak-tube input, and causes the unidimensional output display line (roughly analogous to a raster line) of the streak tube to scan vertically (sideways of the line shape) down the screen.

This scanning, in Applicant's apparatus, is essentially in synchronism (subject to a fixed delay) with the propagation of the essentially unidimensional needle-shaped probe beam through the ocean. In short, the invention operates by a substantially direct streak mapping of (1) lidar penetration depth to (2) display height.

Furthermore, this straightforwardly generated and intelligible image can, if desired, be both viewed and understood in real time by an operator of the system.

Alfano instead, to accomplish his dimensional-compression (3D-to-2D) mapping, inserts in his collection path a specially constructed 2D-to-1D light pipe (43 in his Fig. 5, and 101 in his Fig. 6) which performs an arbitrary, synthetic additional step of spatially coding (1) a two-dimensional image, generated all at once by his planar excitation beam, into (2) a one-dimensional image for presentation to his streak tube.

Alfano thereby generates and records a badly scrambled screenful of such arbitrarily coded lines, while his planar light probe propagates through the turbid-medium volume. He then must set a computer to the task of decoding or unscrambling the whole data array before the data can be made useful.

- Volume display

Because Applicants' system inherently operates in real time, the entire imaging process can be repeated several or many times per second. This process can proceed while a carrying vehicle (airplane, for example) transports the system forward above the ocean surface.

During this activity an operator of the system can watch a moving-picture video-display image -- an image simply enhanced from, *e. g.*, the streak-tube display screen -- which emulates visual perceptions of travel

through the turbid medium. In other words the human viewer can see, still in real time, a close visual analog of what would be seen if it were possible to be carried along through the water, below the surface, but at airplane speeds.

Alfano's system must wait for a computer to unscramble his dimensionally-compressed data and construct, or in some cases reconstruct, desired views before anything can be seen. With data throughput capabilities of ordinary lab or airborne computing gear this would be very difficult in real time.

Applicants respectfully submit that the claims originally filed in this case distinguish the cited art; however, in the interest of more expeditiously securing allowance, all the claims not indicated allowable have been cancelled without prejudice, and a new set of claims submitted. Applicants believe that the new claims more clearly emphasize the several distinctions outlined above.

New claim 36, as mentioned earlier, is derived from the draft claim discussed with Examiner Tung in the telephone interview -- but has been corrected as to several technical details, and also made broader with respect to certain details such as the character of the light source. New claim 33 is in

some respects slightly broader than claim 36, but also narrower in that it specifies more mechanistically how the line-like images are arrayed in proportion to propagation distance and time on a display screen.

New claim 64 employs a very distinct and particular negative-limitation approach to distinguishing the Alfano and Knight references (which employ 2D-to-1D remapping fiber bundles) and the Takaoka reference (which requires an image slicer). The claim also recites that no other type of image remapper is used.

In regard to this recitation, remapping of the *image* (the light returning from the turbid medium of interest) is to be distinguished from remapping of the *projected beam.* Preferred embodiments of Applicant's invention preferably do include compensation devices -- such as the diamond-shaped beam inverter -- to modify the intensity distribution of the outgoing beam.

As explained in the application, such devices operate in such a way as to roughly equalize the intensity of returning light -- apart, of course, from the influence of features of interest within or under the turbid medium. These devices do not, however, scramble or otherwise remap the returning image.

New claim 67 takes rather the opposite approach, being a method claim that is generally equipment-independent -- but that is relatively narrow in its recitation of the transla-

tional geometry used to generate "motion picture" effects. This claim is supported by and reads on Applicants' method as practiced with a streak tube for electronically capturing and time-resolving the line-shaped optical reflections, but would encompass quite different ways of capturing and time-resolving them -- such as for example sensing the light with a line of CCDs, and distributing the resulting successive CCD signals into successive ranks of a memory array.

Conclusion

In view of the foregoing amendments and remarks, Applicants respectfully request the Examiner's favorable reconsideration and allowance of the claims now standing in this case.

In addition, noting the extremely high cost of continuing prosecution of this application -- not only to the Applicants but to the Government as well -- it is earnestly requested that, should there appear any further obstacle to allowance of

the claims herein, the Examiner telephone the undersigned attorney to try to resolve the obstacle.

Respectfully submitted,

PETER I. LIPPMAN
Registration No. 22,835
Attorney for the Applicants

Ashen & Lippman
4385 Ocean View Boulevard
Montrose, California 91020

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TELEPHONE:
818/249-5961